8.0 SUMMARY AND CONCLUSIONS

8.1 PURPOSE

The Coeur d'Alene Basin (CDAB) in northern Idaho includes Lake Coeur d'Alene and the St. Joe and Coeur d'Alene River drainages that are the ancestral home of the Coeur d'Alene Indian Tribe. Since the late 19th century, this area has been the center of one of the most productive mining districts in the world. Significant deposits of gold, silver, lead, zinc and associated metals have been mined and refined in the upper Basin for over a century. The area is known as Idaho's Silver Valley. During most of the last century, substantial quantities of industrial wastes were directly discharged to the environment from mining, mineral processing, and smelting activities, as was common practice at the time. Public health investigations in the 1970s to 1980s resulted in the designation, in 1983, of a 21 square mile area called the Bunker Hill Superfund Site (BHSS), or "the Box," surrounding the former smelter complex near Kellogg. Remedial activities and public health response activities have been ongoing in the BHSS for two decades.

A Remedial Investigation and Feasibility Study (RI/FS) is currently being undertaken to characterize the degree and extent of the contaminant release in the remainder of the CDAB. Concurrent with the RI/FS, this baseline Human Health Risk Assessment (HHRA) addresses potential health risks associated with residual heavy metals contamination in the CDAB for areas east of Harrison upstream from the mouth of the Coeur d'Alene River. A screening level HHRA was previously conducted for Coeur d'Alene Lake beach areas, and a similar screening level HHRA is being conducted for the Spokane River that drains Lake Coeur d'Alene into the State of Washington.

The baseline risk assessment is an evaluation of the potential threats to public health from site contaminants in the absence of any remedial action. To the extent that the risk assessment or any site-specific analyses rely, directly or indirectly, on observed blood lead data; baseline conditions reflect the ongoing public health intervention efforts of the Panhandle Health District. The primary tasks accomplished in performing the HHRA included data collection, data evaluation, exposure assessment, toxicity assessment, and risk characterization. The main purpose of this HHRA is to determine the extent of heavy metal contamination in environmental media that may expose current or future residents or visitors to the CDAB, to evaluate the potential human health risks associated with exposure to those contaminated media, and to provide information for risk managers to evaluate the need for remedial action and development of associated clean-up criteria. Figure 8-1 shows various features of the CDAB.

8.2 STUDY AREA

The CDAB is located in the Panhandle region of northern Idaho and lies within Kootenai, Shoshone, and Benewah Counties. The Basin is on the west slope of the Bitterroot Mountain Range. Summers in the area are generally hot and dry with only about 12% of the annual precipitation occurring between July and September. Approximately 50% of the annual precipitation occurs between November and February. Winter temperatures are 15 to 25 degrees higher than those in continental locations of similar latitude. These weather patterns make the Basin one of the highest precipitation areas of the upper Columbia River Basin and result in the potential for frequent high water events. The remaining precipitation takes place in the spring.

Much of the area is rural and contains a wide variety of landscape types, rich in natural resources including floodplains, steep mountain canyons, and river valleys. Topography and landscape vary in the Basin from relatively open, flat floodplain areas of the Coeur d'Alene River in the western portion of the Basin to steep, narrow canyons to the east. The floor of the valley near the boundary between Kootenai and Shoshone Counties is roughly 1 mile wide and narrows significantly eastward toward Shoshone County. Valley areas near Wallace average 0.25 mile wide.

For the purposes of this HHRA, the study area is from the Idaho-Montana border in the east to Harrison in the west. The 21 square-mile BHSS is excluded from this assessment. Some additional areas, such as regions south of Harrison, Blackwell Island, and Corbin Park beaches, have been identified by the State, EPA, and the Coeur d'Alene Tribe, and are also included as part of this HHRA. Some subareas addressed in this HHRA are discussed as being located in the upper Basin, that is contained in the steep mountain canyon of the South Fork and adjacent tributary gulches east, or upstream, of the BHSS. The upper Basin contains 11 residential cities or unincorporated areas, about half of which are located within the BHSS. Most of the mines and industrial facilities that constitute the Coeur d'Alene mining district are, or were, located in the upper Basin.

Immediately west of the BHSS is the Kingston subarea that includes Kingston, Pine Creek, and the confluence of the North and South Forks of the Coeur d'Alene River. The Lower Basin area west of Cataldo includes 11 lateral chain lakes and extensive wetlands, located adjacent to the main channel and within the Coeur d'Alene River's floodplain. These marshes and lakes provide an extensive recreational area between the town of Cataldo and Lake Coeur d'Alene. Camping, fishing, boating, swimming, hunting, and wildlife photography and observation are popular activities throughout the lower CDAB. There are no incorporated cities between Cataldo and Harrison at the mouth of the main Coeur d'Alene River. However, there are a few small unincorporated village areas and several rural residences.

8.3 RESIDENT POPULATION, LAND-USE, ECONOMY AND HOUSING

Much of the Basin is rural, undeveloped land. Approximately 32 percent of Kootenai County and 75 percent of Shoshone County consist of federally managed lands, primarily National Forests. These areas are rich in natural resources including forests, wildlife, and a number of tributaries and streams that support a variety of aquatic organisms. However, many of these areas are inaccessible due to the lack of roads, difficult terrain, or lack of services. Interstate 90 (I-90) provides limited access to the otherwise rural area.

Tourism related to the use of these natural resource areas for recreational purposes has increased significantly over the last two decades and is one of the fastest growing contributors to the local economy. Recreational use of the abundant natural resource areas include riding off-road vehicles, snowmobiling, berry picking, mountain biking, fishing and floating the Coeur d'Alene River, and cross-country and downhill skiing.

Approximately 10,500 people, or 1% of the total population of Idaho, reside within the study area. The economy of the region, traditionally based on mining, has declined over the last 10 to 20 years due to mine closures, layoffs, and a lack of other industry to replace the mineral-based economy. Between 1980 and 1996, total mining employment decreased by 74%. As a result, the total population shows a declining trend as people move outside of the area seeking jobs.

The population of Shoshone County decreased by 29% between 1970 and 1990. Between 1990 and 1998, the population remained relatively unchanged, with a slight decreasing trend (0.4%). Correspondingly, the unemployment rate increased from 6.7% to 9.9%. Between 1990 and 1996, total employment increased slightly (4%), while mining employment continued to decrease significantly (58%). Tourism and recreation appear to be growth sectors, replacing some of the mining jobs. Unemployment showed a slight increase (0.3%) from 1990 to 1998.

As the younger generation is forced to move outside of the area to find employment, the population of the Shoshone County is becoming older. The median age of residents in Shoshone County in 1970 was 27.3 years as compared to 39.6 in 1998. The percent of the population aged 65 and over in Shoshone County in 1997 was 15.7% compared to 7.1% in 1970. Between 1994 and 1998, the child population under 18 in Shoshone County showed a decrease of 6%, while the total population remained fairly constant. Statewide, the child population showed a slight increase (3%) between 1994 and 1998, with a total population increase of 8%.

From 1990 to 1998, the number of children under the age of 5 years in Shoshone County decreased by 12.1%. Statewide, the number of children under age 5 increased by 12.2%. The number of children between the ages of 5 and 17 in Shoshone County decreased by 7.7%, while statewide, the number increased by 14%. Overall, the total number of children under 18 in Shoshone County decreased by 8.7% and increased statewide by 13.5%.

Socio-economic data for children living in Shoshone County showed higher than statewide percentages of child poverty, single parent families, infant mortality, low birth weight babies, school dropouts, teen births, and teen violent deaths for all years included. As an example, the percentage of children in poverty in Shoshone County increased from 23.7% to 31.2% from 1990 to 1996, while the percentage of children in poverty statewide remained relatively constant at approximately 16% to 17%. Births paid for by medicaid decreased in Shoshone County from 1997 to 1998 (55% to 42%); however, the percentage remained higher than statewide numbers of 33% and 28% for 1997 and 1998, respectively.

The total number of housing units in the Basin Area is 5651, or 1.4% of the total number of housing units in Idaho. The percentage of occupied housing units in the Basin Area (74%) is lower than the statewide percentage (87%) due to vacancies and a high number of seasonal units in some Lower Basin census blocks. The percentage of renter occupied units is lower in the Basin Area than statewide at 23% and 30%, respectively. The statewide average is likely influenced by a higher number of renters in urban areas.

Housing units in the Basin Area are typically older than those reported statewide. Forty-eight percent of the housing units in the Basin Area were built before 1960, and over half (60%) of those were built before 1940. Statewide, only 37% were built before 1960, and less than half of those (44%) were built before 1940. Since 1980, the percentage of houses built in the Basin Area has also been lower than statewide, at 12% and 18%, respectively. From 1990 to 1997 housing growth in Shoshone County was 5.6%, well below the statewide growth rate of 21.6%.

Basin Area housing values were typically lower than the State median with fourteen of the eighteen census block groups included in the Basin Area (78%) having median housing values less than the statewide median of $58,000. The four block groups with median values greater than $58,000 are located within the Kingston and Lower Basin subareas.

The majority of median rent values in the Basin Areas are also lower than the State median rent value of $330. Of the eighteen block groups in the Basin Area, only one (located in the Kingston Study Area) has a higher median rent value.

8.4 DATA USED IN THE HHRA

In addition to traditional geographic, climatic, and demographic information, two basic data sources were used in the HHRA. Those data either i) originated in investigations associated with the RI/FS or the Natural Resource Damage Assessment (NRDA) being conducted under CERCLA by federal and Tribal trustees, or ii) were obtained in health surveys conducted by the State Department of Health and Welfare and allied local and federal health agencies. The principal source of the latter data was a comprehensive blood lead and environmental exposure study conducted in 1996, and follow-up blood lead surveys conducted in 1997-1999.

In 1996, the State of Idaho, the Panhandle Health District (PHD), and the Agency for Toxic Substances and Disease Registry (ATSDR) conducted a large-scale, multimedia exposure study within the Basin. The investigation characterized both environmental contamination and biological indices of human exposure from 843 residential homes in the upper and Lower Basin. The data obtained included blood lead, urine cadmium, yard soil, house mat dust, home vacuum dust, lead-based paint measurements, and tap water. All samples collected were originally analyzed for lead and cadmium.

The 1996 study was followed by fixed-site blood lead surveys during the following three summers. Testing during all four summers produced a total of 524 children in the nine month through nine year old category and 667 adult blood lead observations (Adult blood leads were only collected during 1996). In addition, public health investigations were conducted at the homes of 50 children exhibiting blood lead levels greater than or equal to 10 μg/dl. In July of 1999, a strategy was adopted to augment the existing database with new information sufficient to support site-specific analysis and provide the risk assessment effort with appropriate information to characterize lead exposure in the Basin.

Those public areas, communities, and specific media for which little data were available were sampled in the summer of 1999 by the State of Idaho. A supplemental survey was also conducted by the State of Idaho in November of 1999 that collected environmental samples and survey data from the homes of those children providing blood lead results that had not previously been sampled. Of the 132 homes that were not included in previous efforts, approximately 90 of those homes were sampled in the Fall 1999 survey.

The combined sampling effort from the IDHW study, all EPA residential data, and additional residential data collected by the State of Idaho in the Summer and Fall of 1999 totals 1020 homes, and these are included in the lead risk assessment section.

Non-lead risk assessment data were largely obtained from the federal and Tribal investigations conducted in the course of the RI/FS and associated NRDA. Numerous samples of soil, house dust, tap water, groundwater, homegrown vegetables, sediment, surface water, fish, and plants (i.e., water potatoes) were collected in the CDAB. Because of the large quantity of analytical information available, the data were organized by medium and geographical area; and the methods used for sample analysis and data quality were evaluated. From this, a baseline data set to support the non-lead portions of the HHRA was developed.

Initially, all the available sampling data from the site was reviewed to identify chemicals that might contribute to risk based on concentration and toxicity. Much of the analytical data from these samples were applicable to human exposures. Others were not, primarily because of the sampling location (not a location people frequent) or the sampling methodology. The analytical data selected for use in the HHRA included:

- Blood lead observations from 524 children from 260 homes,
- Yard soil from 191 homes for non-lead metals, 994 homes for lead,
- House dust from 83 homes for non-lead metals, 299 vacuum bag samples and 474 dust mat samples for lead,
- Groundwater from shallow wells in Burke/Nine Mile and Canyon Creeks (for a future scenario, this groundwater is not currently being used as a drinking water source),
- Tap water from 100 homes for non-lead metals, 398 homes for lead,
- Soil from 13 upland parks and schools located in the towns of Silverton and Wallace,
- Soil from five mining waste piles, two near Canyon Creek, two near Nine Mile Creek, and one near Mullan,

- Soil and sediment from 33 beach areas along the lower Coeur d'Alene River, and one beach area in Coeur d'Alene Lake (Blackwell Island),

- Surface water collected adjacent to 33 beach areas along the lower Coeur d'Alene River, and one beach area adjacent to Coeur d'Alene Lake (Blackwell Island),

- Sediment and surface water from Canyon Creek, Nine Mile Creek, Moon Creek, Big Creek, Beaver Creek, and Pine Creek,

- Fish fillet tissue from pike, perch, and bullhead (312 total samples from Medicine, Killarney, and Thompson Lakes) and whole fish tissue data from the Spokane River,

- Produce from 24 residential vegetable gardens, and

- XRF paint lead observations from 417 homes.

8.5 CHEMICALS OF POTENTIAL CONCERN

Chemicals of potential concern (COPCs) were identified using a decision process that included a comparison of detected chemical concentrations with screening values (SV). Additional analysis of a subset of the soil data for other metals (e.g., arsenic, mercury, and zinc) was completed for approximately 80 homes, and these were included in the risk calculations for the non-lead metals in addition to the EPA residential data.

Table 8-1 summarizes the COPCs for each media evaluated. For the solid media soil, sediment and house dust, seven metals including antimony, arsenic, cadmium, iron, lead, manganese and zinc were selected as COPCs. Only lead was selected as a COPC in air.

In water, five metals including arsenic, cadmium, lead, manganese, and mercury were selected as COPCs in surface water for both "disturbed" and "undisturbed" conditions. Five metals were selected as COPCs for groundwater including antimony, arsenic, cadmium, lead, and zinc. Only arsenic and lead were selected for tap water.

For dietary routes all chemicals analyzed in fish including cadmium, lead, and mercury were considered COPCs. The COPCs selected for homegrown vegetables and water potatoes were arsenic, cadmium, and lead.

8.6 TOXICITY ASSESSMENT

A toxicity assessment was developed for each of the COPCs. The toxicity assessment identifies the adverse health effects associated with excess exposure to each metal. In particular, the relationship between the dose of a chemical and the occurrence of toxic effects is evaluated. Toxicity criteria for chemicals (that identify acceptable levels of contaminants) consider both cancer effects and adverse health effects other than cancer (noncancer effects). Generally, the acceptable levels of contaminant intake are based on reference doses related to specific effects for non-carcinogens and slope factors that estimate the potential incidence of cancers associated with the absorbed dose of the chemical.

The toxicity assessment for lead is based on its potential to cause neurological developmental effects in children. The toxicity criteria for lead is related to blood lead levels associated with these effects. The current level of concern is 10 μg/dl of lead in whole blood and is of greatest concern for children and pregnant women (as they represent the developing fetus). Arsenic, the primary COPC after lead, is assessed for its potential to cause skin cancer, frequently fatal cancers of the internal organs (e.g., bladder, kidney, lung, and liver), and various pre-cancer and noncancer effects in skin by ingestion. Arsenic was the only COPC evaluated for cancer effects. The other metals examined have various adverse health effects. Table 8-2 shows the principal health effects for each COPC.

8.7 EXPOSURE SUBAREAS

For the purposes of the ecological risk assessment and the RI/FS, the Coeur d'Alene Basin has been divided into exposure areas based on watersheds and drainage patterns. However, not all portions of the Basin are of concern with respect to human health considerations, and potential human exposures in a number of areas cross the watershed boundaries. As a result, the Basin was divided into eight HHRA geographical subareas based on existing communities, identified routes of potential human exposure, public use patterns, and the results of environmental lead health surveys in each area. Those geographic subareas shown on Figure 8-1 are:

- Lower Basin (the floodplain of the lower Coeur d'Alene River from Harrison to, and including, Cataldo),
- Kingston (the area of the Basin between the 21-square-mile Bunker Hill Superfund area and Cataldo; specifically, the town of Kingston, the confluence of the North Fork Coeur d'Alene River (North Fork) and the South Fork Coeur d'Alene River (South Fork), and residences near Pine Creek, but outside the Bunker Hill area),
- Side Gulches (including residences in the side canyons along streams draining into the South Fork between the Bunker Hill area and Mullan, with the exception of Nine Mile and Canyon Creeks),
- Osburn,
- Silverton,
- Wallace,
- Burke/Nine Mile (including Nine Mile Creek and Canyon Creek), and

- Mullan.

8.8 POPULATIONS OF POTENTIAL CONCERN

Certain population groups in the Basin could be more sensitive to contamination, or more likely to be subjected to greater exposure than the typical individual in each of the receptor groups. These populations include *infants, children* and *pregnant women* as they represent the *fetus*, and individuals with *subsistence lifestyles*, including some members of the Coeur d'Alene Tribe.

Because of their physical vulnerability and small body size, *infants and children* are often more susceptible to the potential toxic effects of chemicals in the environment. Their risks may differ qualitatively and quantitatively from those of adults for a variety of reasons including differences in behavior (e.g., frequent hand-to-mouth behavior), physiology, metabolism, pharmacokinetics, diet, and exposure environment.

Physiological differences include intake rates of air, food, and water (and associated chemicals) per unit of body weight. Similarly, dermal, intestinal, and respiratory absorption may be greater or lesser in children depending on the chemical and the exposure scenario. There are also major metabolic differences between children and adults that can significantly affect their ability to respond to chemical exposure. Pharmacokinetics, including the absorption, distribution, and excretion of various chemicals, differs between children and adults on a chemical-specific basis.

The diet of a child is often quite different from that of adults. Dietary differences, such as the amount of vegetables, fruit, fish, or red meat consumed, can have an effect on the amount of chemical ingested in food items. In addition, nutritional status has a profound effect on toxicity response. There are obvious differences between adults and children in the physical environment and living habits. For example, children are generally closer to the floor, carpet, and ground. Their daily activities, hand-to-mouth behavior, and lack of occupational exposure significantly influence the amount of soil and dust consumed, and chemical exposure that occurs.

As a result, infants and children often receive a different effective dose of a chemical than adults, even when chemical concentrations in affected media are the same. Several poverty-related factors among the resident population cause additional concern for infants and children in this population. The high incidence of teenage pregnancies, infant mortality, low birth weights, and single parent families suggest possible nutritional deficiencies. Vitamin and essential nutrient deficits can contribute to higher metal absorption rates, particularly for lead as the body seeks calcium, and exacerbate adverse health effects for the fetus and infant.

Lower socio-economic status indicated by the 31% of children living in poverty, births paid for by medicaid, school lunch programs, high welfare payments, low-rents, and high unemployment rates are associated with greater risk of lead poisoning. The substantial decrease in young children in the population indicates young families are continuing to leave the area. Increase in welfare payments to the remaining homes with children may indicate the area is attracting and retaining economically disadvantaged families.

Poverty and lead poisoning interact in several ways. Children may have lowered nutritional status and live in poorer quality housing. Parents may experience more difficulties in managing the home and children, and are less able to provide a stimulating and healthy home environment. Home and child hygiene and behavioral risk co-factors can lead to increased ingestion rates of soils and dusts. Yard soils and house dust can be more contaminated due to deteriorating lead paint, proximity to industrial sources, and lesser quality maintenance of the home, yard, and local infrastructure. The age of housing in the Basin is problematic due to the frequent use of lead paint and accumulation of contaminated dusts throughout the last century.

As a result, poor children ingest more soil and dust that has a higher lead content. These children tend to absorb more of the ingested lead than those with a more nutritionally sound diet, resulting in higher blood lead levels. In addition, poor children are more vulnerable to adverse health effects resulting from their lower general health status, and reduced access to quality health care and early childhood educational opportunities. The increased risk of lead poisoning for children in lower socio-economic groups does not imply that other children in the Basin are not at-risk. Poor children are at relatively higher risk than those from more affluent families.

A second population of concern are fetuses, by virtue of maternal exposures to lead and certain non-lead contaminants such as arsenic. Lead crosses the human placental barrier and can expose fetal tissues at the most vulnerable periods of development. Another population of concern are elderly residents whose long-term exposures to lead may result in risk of hypertension or bone demineralizing disorders later in life that might release historically-accumulated bone lead to the blood stream.

Effective dose and routes of exposure can also differ markedly for those practicing *subsistence lifestyles*. The resident riparian lifestyle and harvest techniques employed throughout tribal history represent holistic practices that encompass all activities in an overall lifestyle. Fully addressing potential Native American exposures within the Basin requires consideration of routes of exposure not included in other scenarios in the HHRA. The tribal riparian lifestyle has the potential for significant prolonged exposures to both sediment and water and significant dietary intake. Examples are fishing, consumption of whole fish, and the harvest of the water potato (Sagittaria spp.) at the mouth of the Coeur d'Alene River. Vegetable consumption rates for the Tribe show a strong dependence on the water potato and, traditionally, as much as one-third of the overall diet was resident fish.

The traditional economy of the Coeur d'Alene Tribe was characterized by a complex and highly structured system of food source production, distribution, and consumption. The Plateau people generally practiced a seasonally based cycle of utilization of specific economic resources. This travel involves the return annually to well known camps for root digging, fishing, hunting, and high elevation hunting and berry picking.

The Tribe was largely dependent upon Lake Coeur d'Alene and its tributaries; perhaps more than any other Plateau group. Water played a central role in all aspects of life, from birth to death and was included in all major cultural events. Individuals spent a great portion of their time in the water; generally through fishing, hunting, gathering, bathing, recreating, and other various activities. The basic winter village in the Basin was the center of the cycle and was never fully abandoned by certain individuals of the society, especially the elderly and children too young to travel on their own but too heavy to be carried. The Coeur d'Alene were primarily involved in harvesting, consuming, and utilizing riparian resources. Much of the raw material used in the manufacture of various necessary items was obtained from within the riparian environment.

All of these activities were undertaken collectively in family or tribal groups and involve children and women of reproductive age, that are considered the population at greatest risk.
These activities also result in substantially greater potential exposures associated with consumption rates of resident fish and riparian vegetation, and soil and sediment contact rates associated with typical residence and harvest practices for both ingestion and dermal routes.

Due to the Tribe's dependence on water from Lake Coeur d'Alene, the surrounding lateral lakes, the Coeur d'Alene River, and close interaction with the natural environment, maximum exposures were assumed. Additionally, it is not known how a subsistence diet affects metal absorption rates in the body. Nutritional factors, such as calcium or trace metal deficiencies, and periodic fasting associated with cultural activities or availability of foodstuff could lead to enhanced absorption rates, especially for growing infants and children, pregnant women and fetuses.

8.9 RECEPTORS, EXPOSURE PATHWAYS AND SELECTED SCENARIOS

In order for an adverse health effect to occur, a person must be exposed to the chemical of concern. Residents and visitors to the Basin could be exposed to affected media during their normal daily activities including home life, recreation, and work. However, across the Basin, exposures will not be the same because of differences in activity patterns, e.g., people do not all use the same places for recreation and do not all eat homegrown vegetables. The amount of the chemical (the dose) a person encounters depends on the concentration of the chemical in the medium, the frequency of use of a particular area or medium, the length of time the person is exposed, the person's age, size, and intake of the medium.

Five major population groups were quantitatively evaluated in the risk assessment for a variety of exposure pathways. Inherent in these major groups are various pathways of exposure. For example, day care, school, deposition of wind-blown dusts and tracking of soils into the home are inclusive in the residential scenario. Different exposure pathways were also evaluated depending on the geographical area where they are encountered. For example, no waste pile exposures were evaluated in the Lower Basin because there are no waste piles present. The receptors and exposure pathways that were evaluated fall into one of five exposure scenarios.

The ***residential scenario*** pertains to children and adults who live in the Basin and could be exposed to affected media inside the home, in the yard, and the local community. Estimates of metals intake were developed for incidental ingestion of soil and house dust, dermal contact with soil, ingestion of drinking water, and ingestion of homegrown vegetables. A future drinking water scenario using shallow groundwater collected from metal source areas in Canyon Creek and Nine

Mile Creek was also evaluated for hypothetical residents. Shallow groundwater is not widely used as a drinking water source for Basin residents.

The ***neighborhood recreational scenario*** pertains to children of ages 4 through 11 who would play in their neighborhood in creeks and on waste piles and for whom these exposures would be in addition to the residential scenario. In general, the areas evaluated for neighborhood exposures are undeveloped properties immediately adjacent to residences. Neighborhood recreational scenarios were quantitatively evaluated for exposures from incidental ingestion of sediments, dermal exposure to sediments, incidental ingestion of surface water during water play activities, and exposures to waste pile soils.

The ***public recreational scenario*** pertains to children and adults who use developed parks and playgrounds, and undeveloped recreation areas, whether they are local residents or visitors from outside the area. Public recreational exposures were quantified separately from residential and neighborhood recreational exposures because of the potential for cross-Basin travel and the possibility that visitors from outside the Basin could use the public areas. Public recreational scenarios were quantitatively evaluated for exposures from incidental ingestion of surface soil and sediments, dermal exposure to soils and sediments, incidental ingestion of surface water during water play activities, and ingestion of fish.

The ***occupational scenario*** pertains to adults who could come into contact with affected media in the course of their daily work activities. In general, work exposures would be less than residential and recreational exposures because of more limited contact with the affected media. However, workers who have intensive contact with soils such as during construction activities, might have high exposures for short periods, depending on the work location. As a result, construction workers exposed to soils were quantitatively evaluated in the risk assessment.

The ***subsistence scenario*** pertains to children and adults engaged in traditional (aboriginal) or current subsistence lifestyles in the floodplain of the lower Coeur d'Alene River. These are future scenarios, as subsistence lifestyles are not known to be currently practiced in the floodplain. Exposure pathways quantified for subsistence lifestyles are similar to those evaluated for residential and recreational receptors.

8.9.1 Typical (CT) and Reasonable Maximum Exposures (RME)

All scenarios were evaluated at two levels of probable contaminant intake. Those are called the typical, or Central Tendency (CT), and the Reasonable Maximum Exposures (RME) intake rates. The CT estimate is the most likely or typical amount of contaminant a member of the population will intake for each scenario. The RME represents the largest intake that can reasonably be expected for any individual member of the population. All risk calculations are performed at both levels of potential intake so that risk managers may consider the potential effects for both the bulk of the population and for those individuals most at risk. Generally, the CT estimate is for the 50th percentile of the population and the RME is calculated at the 95th percentile. The results can generally be interpreted to mean that the CT estimate applies to at least half of the population and the RME applies to the 5% of the population most exposed.

8.10 HUMAN HEALTH RISK CHARACTERIZATION FOR METALS OTHER THAN LEAD

8.10.1 Non-carcinogenic Risk

The exposure factors, media concentrations, and toxicity criteria are combined for the non-lead metals to calculate health risks. Health risks for chemicals that cause cancer are calculated differently from health risks for chemicals that cause noncancer health effects. For each non-carcinogenic chemical, there is a "threshold" dose. If a person is exposed to a chemical dose equal to or less than the threshold, no adverse health effects are expected. The chemical dose from the site is divided by the threshold dose to arrive at a "hazard quotient." If the hazard quotient is equal to or less than 1, no adverse health effects are anticipated. Hazard quotients greater than 1 may be associated with an adverse health effect. Noncancer health effects present age-specific concerns because young children are often more sensitive than adults. As a result, noncancer health risks were calculated separately for young children in addition to children and adults combined.

Summary hazard results for non-carcinogenic effects are provided in Tables 8-3 through 8-6 and are discussed by Exposure Scenario below. Risks and hazards for the traditional subsistence scenario were the highest of any receptor population. Current and traditional subsistence exposures were evaluated only as future scenarios because subsistence lifestyles are not known to be currently practiced in the floodplain. For both exposure scenarios, hazard quotients were greater than 1 for each age group, with hazards for the traditional scenario being at least three times higher than hazards for the current exposure scenario (Table 8-6). Risks and hazards for the current subsistence scenario were similar to those for the highest residential areas.

For both the current and traditional subsistence scenarios, arsenic and iron in soil and sediment were the greatest contributors to noncancer hazards. Hazards from fish ingestion are likely underestimated for subsistence exposures because the whole fish is consumed. Hazards are estimated using data on fish fillets, that have substantially lower metals concentrations (e.g., an order of magnitude) than whole fish.

For typical (CT) exposures to the resident population, potentially unacceptable hazards occur only for resident children in the Side Gulches when all exposure routes are combined and for future child, and for future child/adult residents of the Burke/Nine Mile area, if they were to use groundwater as a domestic supply. In general, the hazards and risks calculated for typical (CT) exposures were lower by approximately an order of magnitude compared to those calculated for RME conditions. All other excess hazard quotients discussed are for RME conditions.

For the resident population, soil ingestion pathways contributed the most to risk and hazard totals, with soil ingestion generally contributing more than 90% of the noncancer risk. Hazards from arsenic contributed 40% to 65% of the total hazard for residents, and iron was the second largest contributor, accounting for 20% to 35% of the total residential hazard. However, in most cases the hazard due to iron did not exceed the target hazard quotient of 1.

In addition to arsenic, other chemicals exceeded a hazard quotient of 1 for a few age groups, pathways, and areas under RME conditions. Exposures to other chemicals with hazard quotients greater than 1 were the following:

- Cadmium hazards to residents from eating homegrown vegetables, and to traditional subsistence receptors from eating water potatoes,

- Iron hazards from ingesting soils and sediment in the Lower Basin (0- to 6-year age group for residential receptors and all ages for subsistence scenarios),

- For the hypothetical future scenario that includes drinking shallow groundwater in the Burke/Nine Mile area, cadmium and zinc hazards from drinking groundwater (0- to 6-year age group and 0- to 30-year age group), and

- For the current subsistence scenario, mercury in fish and for the traditional subsistence scenario, mercury in fish, and manganese and iron in soils and sediments.

8.10.2 Arsenic Carcinogenic Risks

Cancer risks are calculated under the assumption that no level of the chemical is without some risk. Risk indices are presented as a probability of developing cancer, e.g., an increased risk of developing cancer of 1 person in 1,000,000 (a 1×10^{-6} cancer risk level). The U.S. Environmental Protection Agency (EPA) uses the general 10^{-4} to 10^{-6} risk range as a "target range" within which the Agency strives to manage risks as part of a Superfund cleanup. Once a decision has been made to take an action, the Agency has expressed a preference for cleanups achieving the more protective end of the range (i.e., 10^{-6}), although waste management strategies achieving reductions anywhere with the risk range may be deemed acceptable. Furthermore, the upper boundary of the risk range is not a discrete line at 1×10^{-4}, although EPA generally uses 1×10^{-4} in making risk management decisions. A specific estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions, including any remaining uncertainties on the nature and extent of contamination and associated risks. Therefore, in certain cases EPA may consider risk estimates slightly greater than 1×10^{-4} to be protective (U.S. EPA 1991d).

For carcinogens, the greatest health concerns are doses over the entire lifetime and cancer risks are calculated for children and adults combined, assuming exposure over a lifetime. Arsenic was the only carcinogen evaluated and the only chemical other than lead evaluated for the drinking water pathway (other chemicals and pathways were screened out because they did not pose a health risk).

The highest cancer risks are associated with subsistence lifestyles. RME cancer risks exceeded 10^{-6} in all exposure pathways, with cancer risks ranging from approximately 4 x 10^{-5} to 1 x 10^{-3}. Table 8-6 shows the RME cancer risk for arsenic for the traditional and current subsistence exposure scenarios for the combined adult/child age group. Total RME cancer risk is approximately 4 x 10^{-3} for the traditional scenario, and 8 x 10^{-4} for the current scenario. This suggests unacceptable cancer risks from exposure to arsenic through all media and pathways.

For the resident population, cancer risks were evaluated for two age groups: child/adult, age 0 to 30, and occupational adult, 25 years of exposure. As shown in Table 8-3, total RME cancer risk for each scenario was in the range of 10^{-6} to 10^{-4}, except for the residential scenario at the Side Gulches where the RME cancer risk was 3 x 10^{-4}. CT cancer risk for each scenario was also in or below the range of 10^{-6} to 10^{-4}.

For the residential scenarios, exposure to arsenic in yard surface soil contributed most of the total RME cancer risk. Arsenic in tap water also contributed significantly to total RME cancer risk for residents at the Side Gulches. Although tap water was not the primary contributor to cancer risk for the residential scenarios, RME cancer risk for tap water exceeded 10^{-6} in all exposure areas.

For the special case future residential scenario in Burke/Nine Mile, groundwater contributed approximately 20% of the total RME cancer risk. Arsenic risks in surface/subsurface soil for construction workers ranged from 3 x 10^{-5} to 1 x 10^{-4}. For recreational scenarios in each exposure area, the following media contributed to most or all of RME cancer risk due to arsenic:

- Soil/sediment in the lower Coeur d'Alene River for the Lower Basin (highest concentrations of arsenic in the entire Basin with the exception of waste piles),
- Soil/sediment at the North and South Fork confluence in Kingston,
- Upland surface soil from the Elk Creek area and sediment from Elk Creek Pond in the Side Gulches (Elk Creek area soil and sediment had the second highest arsenic concentrations in the entire Basin after floodplain soil/sediments in the Lower Basin),
- Sediment in the South Fork (Osburn, Wallace, and Silverton neighborhood exposures),
- Surface soil from waste piles in Burke/Nine Mile,
- Soil in waste piles and sediment in the South Fork in Mullan, and
- Soil/sediment from the Spokane River on Blackwell Island.

Cancer risks were calculated on the basis of total arsenic concentrations in each area. However, some of the arsenic is naturally present (pre-mining background concentration) and may be contributing significantly to the total arsenic concentration in soil and sediment. Risk management activities typically take background concentrations into account for decisions about remediation. As a result, background may account for a percentage of the risk due to arsenic in some areas and may affect remedial decisions.

8.10.3 Non-lead RME Residential and Neighborhood Risks and Hazards

Under current conditions, the Side Gulches had the highest risks and hazards for the 0- to 6-year age group and the combined children and adults age group (Table 8-3). The Lower Basin had the second highest risks and hazards for these age groups. The Lower Basin had the highest concentrations of arsenic and iron in soil and sediment (except for waste piles). The higher risks and hazards in the Side Gulches were due to high concentrations of arsenic in water in one private well. The Burke/Nine Mile area had the highest neighborhood risks and hazards because of the waste pile exposures evaluated for this area. Waste piles had the highest concentrations of non-lead metals.

Some additional hazards over target health goals for the 30-year period evaluated for child and adult residents exist if elementary-aged school children play in mining-affected media in their neighborhoods, particularly in the Side Gulches and Burke/Nine Mile areas. Additional risks and hazards for residents from arsenic and cadmium in vegetables are also a potential concern.

The hazard quotients in Table 8-3 represent the sum of hazards from all chemicals, and the majority of the hazards are due to arsenic and iron (60% to 100%). There is no evidence that the toxic effects of these two chemicals are additive: the noncancer hazard for arsenic is based on adverse effects on the skin, while the hazard for iron is based on adverse effects on the blood-forming system. For example, the hazard quotient of 5 for the Lower Basin comprises an arsenic hazard quotient of 2.4, an iron hazard quotient of 1.6, and a hazard quotient of 0.6 for the other metals of concern.

8.10.4 Non-lead RME Public Recreational Risks and Hazards

Of the 8 geographical subareas evaluated for recreational exposure, five had public recreational areas with sampling results. Hazards from the use of these areas exceeded 1 for the 0- to 6-year age group only along the lower Coeur d'Alene River from the confluence of the North Fork and the South Fork downstream to Harrison (Table 8-4). Cancer risks were highest for this area as well.

8.10.5 Non-lead RME Occupational Risks and Hazards (Construction Worker)

Of the 8 geographical subareas, five were evaluated for risks and hazards to construction workers actively engaged in work that involves soil disturbance. As with the other populations evaluated, risks and hazards were highest in the Lower Basin, and the Lower Basin is the only area where hazards exceeded 1, with a hazard quotient of 0.9 for arsenic and 0.7 for iron (Table 8-5).

8.10.6 Non-lead RME Current and Traditional Subsistence Exposure Scenarios (Tribal Members)

Risks and hazards for the traditional subsistence scenario were the highest of any receptor population. Cancer risks for both the current and traditional exposure scenarios were greater than 10^{-6}. Total RME hazard indices for noncancer effects were greater than 1 for each age group in both the current and the traditional subsistence exposure scenario with the child in the traditional scenario having the greatest hazard quotient of 49. The total noncancer hazards for the adult/child and adult age groups for the traditional subsistence scenario were 10 and 21, respectively.

- For subsistence children, exposure to metals through all exposure pathways, except the ingestion of disturbed surface water, represents potentially unacceptable risk for noncancer health effects. Ingestion of surface soil and ingestion of sediment contribute most to the total RME hazard index for the traditional subsistence exposure scenario with hazard indices of 21 and 13, respectively.

- For the combined subsistence adult/child age group, the total hazard index exceeded 1 for each exposure pathway except dermal absorption from surface soil and ingestion of disturbed surface water. Ingestion of water potatoes, ingestion of surface soil, and ingestion of undisturbed surface water are the greatest risk drivers for this age group. The key metals contributing to the total RME hazard are arsenic, cadmium and iron.

- Ingestion of fish was the only pathway evaluated for the subsistence adult age group. The total hazard index for fish ingestion exceeded 1, with mercury in fish being the most significant risk driver.

The hazards from eating fish are underestimated for subsistence populations because tissue concentration estimates are based on concentrations in fish fillets. Some tribal members eat the whole fish, not just the muscle tissue, and concentrations of metals in whole fish are greater than those in fillets. In addition, fish fillet data are from the lateral lakes, not Lake Coeur d'Alene. Sufficient fish tissue data were not available from Lake Coeur d'Alene to characterize health risks; however, tribal populations do eat fish from the lake. As a result, tribal health hazards due to fish consumption from Lake Coeur d'Alene are unknown.

8.10.7 Risks and Hazards for Combined Non-lead Exposures

Risks and hazards were not added across exposure scenarios because residential exposures assume people spend most of their time in the home environment. However, for example, if resident children were to play on a waste pile, eat homegrown vegetables, and recreate in the Lower Basin, their risks may be higher than those for residential children who spend the majority of their time at home. In contrast, if people spend significant amounts of time in areas with metal concentrations that are lower than those in their homes, overall risks would be lower.

The hazard quotients and risk estimates developed for non-lead metals should be considered as potentially underestimating noncancer risks for these populations due to additional exposures to lead. Lead is known to have adverse effects to many of the same organ systems of concern in the development of the hazard indices. Potential lead effects are not accounted for in these risk estimates, although substantial lead intake rates are anticipated for these populations. Lead risk assessment is addressed by a separate methodology below.

8.11 HUMAN HEALTH RISK CHARACTERIZATION FOR LEAD

8.11.1 Observed Blood Lead Levels

Lead health surveys conducted by State and local public health authorities note excessive levels of lead absorption in children throughout the Basin. Little problem is noted among adults, particularly in women of reproductive age, although specific data are not available for pregnant women. The risks associated with blood lead levels are characterized by comparison to current Centers for Disease Control (CDC) criteria: excessive prevalence of blood lead levels in the 10 µg/dl -14 µg/dl range are indicative of excess exposure in a community (Class IIA); levels of 15-19 µg/dl are indicative of excessive lead absorption and require education and nutritional intervention and more frequent screening (Class IIB). Levels of 20-44 µg/dl require medical and environmental intervention and perhaps chelation (Class III). Levels of 45 and higher (45-69) require environmental and medical intervention with chelation therapy (Class IV). Children with blood lead levels at or above 70 µg/dl require hospitalization and chelation therapy, along with immediate environmental management (Class V). Critical incidence criteria correspond to current Public Health Service recommendations of no more than 5% of children exceeding 10 µg/dl and less than 1% greater than 15 µg/dl.

Figures 8-2 and 8-3 summarize observed blood lead data for children in the Basin combined for the years 1996 to 1999. The highest toxicity rates among nine month to nine year old children are observed in Burke/Nine Mile at 21% exceeding 10 µg/dl, 13% exceeding 15 µg/dl, and 4% with levels of 20 µg/dl or greater. The Lower Basin/Cataldo subarea showed the next highest toxicity rate with 18% exceeding 10 µg/dl and 5% greater than the 15 µg/dl criteria. No children were in the 20 µg/dl range in the Lower Basin. Wallace, Mullan and Silverton, respectively, showed 13%, 11%, and 8% of children with levels of 10 µg/dl, or greater. From 4% to 5% of children tested in Wallace and Silverton exhibited blood lead levels exceeding the 15 µg/dl criteria and 1% exceeded 20 µg/dl. Osburn and the Side Gulches area showed 4% of children exceeding 10 µg/dl and only one child in four years exceeded 15 µg/dl. Kingston showed 11% greater than or equal to 10 µg/dl and 7% exceeded the 15 µg/dl criteria.

The highest blood lead levels are observed in the youngest age groups. One and two year old children have arithmetic mean blood lead levels of 7.0 µg/dl and 8.0 µg/dl , respectively, and geometric mean concentrations of 6.2 µg/dl to 6.3 µg/dl. Geometric mean levels then decrease with age from 5.2 µg/dl at age 3 to 3.0 µg/dl at age 8.

The percent of children to exceed critical toxicity levels differs markedly with age. In the lowest age groups, 9 months to 3 years, 19% to 26% of children Basin-wide exceed 10 µg/dl. The rate is highest in 2 year old children with 17% of this group exceeding 15 µg/dl. For four year old children, 12% exceed 10 µg/dl and 5% exceed 15 µg/dl. In older children, the percent to exceed 10 µg/dl ranges from 5% to 8%, and 1% to 3% exceed 15 µg/dl. Figures 8-4 and 8-5 summarize these results.

8.11.2 Representativeness of the Surveys

Approximately 25% of eligible children participated in the surveys. Participation was lowest among younger children. There are divergent opinions as to how well the health surveys represent non-participants from throughout the Basin. Selection bias may have occurred related to individual family decisions to participate and current representativeness is unknown. One argument suggests that the incidence of lead poisoning is likely greater among non-participants, as families that did have their children tested are more attentive to lead poisoning and have benefitted from the local health department's efforts to assist parents in reducing exposures. A counter argument suggests that paying each child $40 as an incentive in 1999 favored low-income participation. Because potentially high exposures are associated with poverty-related factors, higher than average blood lead concentrations would be expected among the participants. There is also concern that younger children were under-represented in the surveys. Because young children typically have higher blood lead levels, overall population means and percent to exceed critical toxicity levels may be biased low. This could affect comparisons of model predictions to observed blood lead levels.

8.11.3 Follow-up of Children with High Blood Lead Levels

Follow-up investigations were completed by the local health department for 50 of 58 children whose blood lead levels exceeded 10 µg/dl. Twenty-five investigations involving 21 individual children were conducted for observed blood lead levels exceeding 15 µg/dl. Risk profiles indicate excess absorption associated with high soil and dust concentrations at homes in the Burke/Nine Mile subarea. Older children's risk profiles in this area also indicate recreational exposures in neighborhood areas contaminated by tailings. High blood lead levels in Wallace are indicated for younger children and are possibly associated with paint and remodeling problems, high soil lead levels in play areas, and dusty or difficult to clean homes. Both Mullan and Osburn had no children greater than the 15 µg/dl blood lead criteria and children's blood lead levels in the 10 µg/dl to 14 µg/dl range were associated with high residential soil and dust concentrations or play in contaminated areas. West of the BHSS, excess absorption was associated with either homes that had been flooded and were contaminated with sediment and flood debris; or with extended recreational activities in the river or lateral lakes areas of the Lower Basin.

8.11.4 Site-specific Analysis of Paired Blood and Environmental Lead Data.

Site-specific quantitative analysis of the relationship between blood lead levels and environmental variables indicate that contaminated soils, house dust, and lead based paint are all related to excess absorption. The overall results suggest complex exposure pathways, with blood lead levels most related to dust lead loading in the home, followed by independent effects of yard soil lead, interior paint lead condition, and exterior paint lead content. The dust lead pathway is most influenced by outdoor soils, augmented by paint contributions in older homes, especially those in poor condition. The overall effect is exacerbated by dusty conditions in Burke/Nine Mile and to a lesser extent in Wallace. The Lower Basin is a notable exception. High blood lead levels are observed, although little problem is indicated with respect to dustiness or house dust lead concentrations in the Lower Basin. High blood lead levels in the Lower Basin have been associated with homes that were flooded in 1996 and recreational activities outside the home environment.

Quantitative models relating blood lead levels to soil, house dust, and paint lead levels and house dust levels to soil and paint sources were developed. These were used to quantify baseline exposures and project risk reductions that might be achieved through source modifications.

8.11.5 Biokinetic Predictions of Resident Children's Blood Lead Levels

The IEUBK model is used to estimate the average blood lead level expected for a typical child ingesting lead through soil, house dust, paint, and water, and also estimates the percentage of children predicted to exceed certain blood lead levels. Residential baseline (everyday home life) blood lead predictions were estimated using four different applications of the IEUBK Model. Both the EPA Default Model (using national assumptions for soil and dust ingestion rates and bioavailability) and the Box Model, derived specifically for the BHSS, were employed. The Box Model uses a lower bioavailability estimate and includes a community-wide component for soil/dust exposure that is not included in the EPA Default Model.

The EPA Default version of the IEUBK Model Batch Mode application predicts a greater than 5% exceedance of the 10 µg/dl health criteria, ***associated with baseline residential exposures***, for all geographic areas. The Box Model predicts exceedance greater than 5% for Mullan, Burke/Nine Mile, Wallace, Silverton, and the Lower Basin. The areas adjoining the BHSS including Kingston, Osburn, and the Side Gulches are projected at less than 5% exceedance for baseline residential exposures by the Box Model. Figures 8-6 and 8-7 show observed and predicted blood lead levels and percent of children to exceed 10 µg/dl for both the EPA Default and Box Models using the batch mode. The results suggest that there are potentially three different exposure situations ongoing in the Basin with respect to the residential soil and dust lead.

East of (and including) Wallace, the baseline Box Model is a better predictor of observed mean blood lead levels. In these areas, the EPA Default baseline model significantly over-predicts both observed concentrations and the percent of children to experience excess absorption. Both models predict more than 5% of 0-84 month old children will exceed the 10 µg/dl criteria in Mullan, Wallace, and Burke/Nine Mile. The EPA Default Model predicts 40% to 50% exceedance in these areas, and the Box Model predicts 15% to 20% above the criteria. Observed exceedance in these areas ranged from 13% to 22%.

Immediately east of the BHSS in Osburn, the Side Gulches, and Silverton, the baseline Box Model fairly-well describes both observed mean blood lead levels and the percent of children exceeding the health criteria. Observed exceedance of the 10 µg/dl criteria for 0-84 month old children ranged from 0% to 11% in this reach. The EPA Default Model predicts 16% to 26% exceedance ***associated with baseline residential exposures*** for these areas, as opposed to the Box Model 4% to 8% projection.

West of the BHSS, and particularly in the Lower Basin, the Box Model is ineffective in describing observed absorption, under-predicting both mean blood lead levels and percent exceedance. Both the EPA Default and Box Models failed to predict these high blood lead levels. The EPA Default Model fairly-well describes mean blood lead levels, but fails to capture the percent of children to exceed health criteria. The Batch mode estimates for Kingston (17% observed greater than 10 µg/dl) were 10% and 2%, respectively, for the EPA Default and Box models. For the Lower Basin (32% observed greater than 10 µg/dl), the respective batch mode predictions were 20% and 13%. This suggests that significant Lower Basin exposures may be occurring outside the immediate home environment.

There are several possible factors that could contribute to the difference in exposures and blood lead levels among these areas of the Basin. There could be physical and chemical differences in the soil and dust contaminants. Differences in chemical form, particle size and matrix effects could result in different physical accessability and bioavailability to children. These differences could be attributable to the original source of the lead from mine, mill or smelter wastes, or from the degree of weathering and secondary mineralization that has occurred while in the environment.

The degree of dustiness and snow cover in these communities could be a factor, as the larger communities have curbs and gutters and other infrastructure that is not available in the smaller villages. The size of yards, use of lead paint, age of the communities and proximity to industrial or transportation sources could all impact this relationship. The habits and behavior of children, particularly as they move about neighborhoods and select favorite play areas and activities may present important differences in exposures between the larger cities, small residential areas or rural homes.

8.11.6 Lead Health Risks from Exposures Outside the Residential Environment

Lead exposures from sources or activities outside the home environment were evaluated by adding *incremental intake rates associated with the other exposure scenarios to the residential estimates*. Potentially significant recreational exposures are noted for children engaged in certain activities in particular areas of the Basin. Upland park type recreation can result in significant exposures in the more contaminated areas of the Upper Basin and throughout the floodplain areas west of the BHSS. Potential recreational exposures in the Lower Basin are more significant because of both higher soil concentrations and lower baseline residential exposures. This can result in higher dose response rates to incremental exposures at lower blood lead levels. This is a possible explanation for the higher than predicted blood lead levels observed among Lower Basin children.

Additionally, swimming and water sport activities that could result in ingestion of disturbed sediment-laden surface water can result in substantial increases in intake and lead absorption. Potential exposures to neighborhood stream sediments in Burke/Nine Mile, and at public swimming areas in the Side Gulches and the Lower Basin are of particular concern.

Potentially significant increases in blood lead levels could also result from consumption of home grown vegetables. Increased intake from foodstuff can result in higher blood lead levels due to the high bioavailability of dietary lead.

For typical adult recreational activities, less than 5% probability of exceeding 10 µg/dl is predicted for all recreational area soil concentrations observed in the Basin. For intense soil contact recreational practices such as dirt biking, beach activities, four-wheeling, gardening, landscaping, etc., that involve deliberate and continued contact with soils, 95th percentile blood lead estimates exceed 10 µg/dl at concentrations ranging from 3700 mg/kg to 6400 mg/kg lead. These values generally represent the 90th to 95th percentile concentrations in Upper Basin recreational areas and 50th to 95th percentiles among Lower Basin common use areas.

Adult blood lead model estimates were developed for medium intensity soil contact occupations or jobs involving periodic exposure to soil sources, such as public property maintenance, typical construction workers, or laborers. These results suggest that exposures to soils ranging in lead concentration from 2800 mg/kg to 4500 mg/kg could result in more than a 5% probability of blood lead greater than 10 µg/dl. Few soil concentrations in this range are observed in residential areas of the Basin. In Upland Park common use areas, these values correspond to the 90th to 95th percentile of sites. In the Lower Basin floodplain 50% to 95% of soils exceed these levels.

Intensive or RME exposure refers to individuals whose employment specifically involves exposures to soils such as landscapers; farmers and agricultural workers; remediation workers; construction workers routinely involved in excavation, demolition, or site development; or utility or road workers. For these workers, soils near 500 mg/kg could result in more than a 5% probability of having a blood lead level greater than 10 µg/dl. Mineral industry workers are specifically excluded as exposure to lead is specifically regulated by occupational health authorities. Although individuals are not evaluated in this HHRA for lead exposure in the workplace, they are considered in the residential scenario.

8.11.7 Native American Blood Lead Levels

Blood lead levels were not predicted for either the traditional or current subsistence scenarios because extremely high estimated intake rates coupled with cultural-specific dietary and behavioral considerations invalidate current blood lead models. Nevertheless, projected intake rates are sufficiently high to indicate that blood lead levels associated with subsistence activities in the floodplain of the Lower Basin would exceed any current health criteria for children or adults in either scenario.

It is important to note that the high lead intake rates are associated with several media. Soil and sediment intakes, fish fillet and peeled water potato, and ingestion of disturbed surface water during swimming and bathing activities would each individually result in excessive lead intake. Consumption of whole fish from the Spokane River or un-peeled water potatoes from the Lower Basin would present especially dangerous intake levels. It is likely that background or pristine environmental concentrations would be required for all media to safely support Native American subsistence activities.

8.11.8 Lead Health Risk Reduction Strategies

These overall results suggest complex pathways of exposure are ongoing in the Basin. Resident children's blood lead levels are most related to dust lead loading in the home, followed by independent effects of yard soil lead, interior paint condition and exterior lead paint content. The dust lead pathway is most influenced by outdoor soils, but is augmented by paint contributions particularly in poorly maintained older homes. The overall effect is exacerbated by extremely dusty conditions in Burke/Nine Mile and to a lesser extent in Wallace. Significantly less problem is noted with respect to dustiness or dust concentrations in the Lower Basin. West of the BHSS, excess absorption was associated with either homes that had been flooded or extended recreational activities in the river or lateral lakes areas.

Potentially significant recreational exposures are noted for certain activities in particular areas of the Basin and from consumption of home grown vegetables. Excessive occupational exposures could occur with particular unprotected jobs in highly contaminated areas. Subsistence Native American practices in the Lower Basin would be dangerous, particularly if whole fish or unpeeled water potatoes contribute a substantial portion of the diet.

These pathways suggest an integrated approach to risk reduction may be advised. Baseline residential exposures could potentially be reduced through cleanup of excessive soil contamination coupled with paint stabilization to simultaneously reduce direct exposure to these media and subsequent house dust lead concentrations. Targeted cleanups of recreational areas, coupled with access limitations or appropriate warnings, could be used to prevent excessive incremental exposures. Provision of clean gardening media could reduce incremental exposure to local produce. Worker safety protocols could be developed to protect adults while employed in contaminated soil related jobs. Native Americans should continue to refrain from food harvest and subsistence activities in the Lower Basin until substantial improvements are made. Individual children's problems could be addressed by continuing and enhancing current health intervention activities until final remedial determinations are completed.

For the resident population, children's baseline blood lead levels are likely to be the determining factor in establishing media-specific remediation goals or concentration action levels. The baseline blood lead levels then become a critical determinant in developing required risk reduction strategies for incremental, or away from home, activities. As a result, it is possible to discuss preliminary potential cleanup levels for risk manager's consideration for children's baseline residential exposures and adult occupational and recreational activities.

However, discussion and development of candidate action levels for children's incremental recreational activities and fish and local produce consumption cannot be addressed in this document. Appropriate risk reduction methods and action levels will have to be evaluated by risk managers after fundamental approaches to reducing baseline blood lead levels have been made. Determining whether these actions would be sufficient to reduce non-lead risks to acceptable levels must also be accomplished in relation to actions addressing cumulative lead exposures.

8.11.9 Biokinetic Blood Lead Modeling for Residential Cleanup Levels

In the upper Basin, outcome house dust lead levels are critical determinants of the efficacy of any cleanup strategy. Substantial reduction of upper Basin house dust lead levels will be necessary under any scenario to achieve acceptable blood lead levels.

Quantitative estimates of house dust and blood lead levels associated with proposed remedial activities were developed from the site-specific analysis. These analyses suggest that blood lead levels are highly dependent on dust lead loading rates, yard soil contamination levels, and paint lead, particularly in poorly maintained housing. Dust lead loading rates, in turn, are dependent on both dust loading, or dustiness in a community, and the lead content of that dust. Outdoor soils, both in the yard and the community, are the primary determinant in dust mat lead concentrations augmented by interior paint lead levels, again in poorly maintained housing. Dust lead inside the home is dependent on dust mat lead, yard soil and interior paint concentrations.

Post-remedial dust lead concentrations for input to the IEUBK model were estimated by the regression model equation that quantitatively describe these pathways. This was accomplished by first estimating post-remedial soil concentrations based on replacing all home yards with soil lead levels exceeding the cleanup threshold with 100 mg/kg lead soils. These soil concentrations were then substituted into the model equations assuming a mean paint lead concentration and good paint condition. This implies that paint stabilization has been implemented. Mat and vacuum dust lead concentration were then successively estimated. The vacuum dust lead estimate was applied with the individual soil concentrations in the batch mode of the IEUBK for all ages of children and the results were aggregated for risk estimates.

Preliminary analysis, using the Box Model, suggests that a cleanup threshold for soils of 800 mg/kg to 1000 mg/kg is necessary to achieve risk levels in the upper Basin comparable to those established for the BHSS. The EPA Default Model suggests cleanup levels for soils below 400 mg/kg are required to achieve similar risk criteria. These results are summarized in Figures 8-8a through 8-8h.

Both models indicate that lead paint stabilization will be required in combination with soil remediation to reduce house dust lead concentrations to protective levels. Potential paint stabilization would apply to the approximately 20% of housing units that currently have lead paint in poorly maintained condition. These measures will not resolve excessive blood lead levels observed in the lower Basin.

In the Lower Basin, and to a lesser extent in the Kingston subarea, yard soil and house dust lead concentration reductions are likely to be less effective in reducing observed high blood lead levels. Residential soil and dust lead concentrations in these areas are generally low and projected residential intake rates do not suggest an excess absorption problem. For these areas, excepting some individual situations, development of strategies addressing incremental exposures outside the home environment are more likely to be effective in reducing risk of lead poisoning.

There are two major considerations in assessing these results. First, the risk of exceeding the health criteria projected in this analysis only accounts for baseline (or home residential) exposures after paint stabilization. Consequently, there is no safety margin allowing for incremental exposures that might occur in addition to home exposure. Second, current USEPA policy addresses individual risks for those children left at the highest exposure levels. Current policy recommends that the probability of the typical 0-84 month old child at any residence experiencing a blood lead level of 10 µg/dl or greater, be less than 5%. Box Model estimates of individual risks indicate this criteria is considerably more stringent than that applied at the BHSS and would require a soil cleanup in the 600 mg/kg to 800 mg/kg range. Using the EPA Default Model to calculate a residential soil cleanup level protective of risk to individuals results in a soil level below the EPA residential soil screening level of 400 mg/kg. This is caused be elevated levels of lead in house dust in portions of the Basin. As a result, risk managers, public health officials and community representatives will need to assess the applicability of this criteria to the Basin population and alternative risk reduction techniques that might provide the necessary level of protectiveness.

8.11.10 Lead Health Risk Reduction for Childhood Recreational Activities

Substantial increases in blood lead levels are predicted for particular play activities in contaminated areas of the Basin. Blood lead increments to existing baseline or residential conditions were developed for this report. However, determination of appropriate risk reduction action levels for soil and sediments in recreational areas cannot be accomplished until appropriate risk management strategies for residential sources have been identified.

8.11.11 Lead Health Risk Reduction for Childhood Consumption of Local Foodstuff

Similarly, the significance of local produce and fish from the lateral lakes area depends on the relative baseline residential blood lead level. In this case, a determination of allowable dietary intake based on baseline blood lead levels will be required. These can be compared to incremental fish and local produce intake tables relating intake to media contaminant levels.

8.11.12 Lead Health Risk Reduction for Adult Occupational Activities

Estimated blood lead levels associated with potential soil and dust concentration levels in occupational activities suggest that in order to maintain 95% of reproductive aged women's blood lead levels below 10 µg/dl, protective measures should be taken for typical workers when in contact with soils exceeding 2800 mg/kg to 4500 mg/kg lead. For those workers engaged in heavy contact with soils for extended periods of time working, the corresponding level of concern is 500 mg/kg lead.

8.11.13 Lead Health Risk Reduction for Adult Recreational Activities

Estimated blood lead responses for Upland Park or land-based recreational activities suggest protective measures should be employed for adults engaging in intense soil-related recreational practices with soils exceeding 3700 mg/kg.

8.11.14 Lead Health Risk Reduction for Adult Consumption of Local Foodstuff

Some local vegetable garden produce shows high lead content that could substantially increase total intake to levels of concern among pregnant women. Adult consumption of local fish adds minimally to total intake at typical fish fillet lead concentrations. However, at maximum concentrations and consumption rates the increased intake could be of concern, although it is unlikely that the species of fish providing the samples would be consumed in large amounts.

8.11.15 Lead Health Risk Reduction for Native American Subsistence Activities

Native American subsistence practices in the Lower Coeur d'Alene Basin would be ill-advised. Soil and sediment ingestion rates associated with residence in the floodplain and food harvest practices are extremely high. Near background level concentrations would be required to achieve acceptable intake rates for soils and sediments. Additionally, two critical elements of the native diet, fish and water potatoes, contain unsafe levels of lead when aboriginal consumption rates are applied. Lead levels in these food sources may also likely need to be in equilibrium with background soil and water conditions to assure acceptable intake rates.